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DESIGN OF STONE DUST STABILIZED ROAD

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ABSTRACT

Soil is the foundation material which supports loads from the overlying structure. Soil is the most widely used material in a highway system, either in its natural form or in a processed form. Also, all pavement structures eventually rest on soil foundation. The construction cost can be considerably decreased by selecting local materials including local soils for the construction of the lower layers of the pavement such as the sub-base course. The present study is aims to design of pavement thickness for both unstabilized and stone dust stabilized soil. Stone Dust is procured from the Pal Stone Industry Halduchaur, the soil is excavated from the the campus of G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India. The material was extracted from 60cm below the ground surface. The overall testing program was conducted in three phases. In first phase, the geotechnical characteristics of the soil were studied by conducting laboratory tests such as compaction test, California bearing ratio test, specific gravity, unconfined compression strength test, direct shear test and consistency limit test. In second phase, the geotechnical characteristics of the stone dust were studied by conducting same laboratory tests as above. In third phase, the pavement thickness is calculated for unstabilized soil and stone dust stabilized soil which was obtained by adding optimum percentage of stone dust based on CBR test.

Keywords: Design, IRC 37:2001, Stone Dust, Stabilized soil, Unstabilized soil.

1. INTRODUCTION

Soil stabilization is a technique to improve physical, chemical, biological, or combined properties of natural soil to meet an engineering purpose. The main objective of soil stabilization is to improve the California Bearing Ratio of in-situ soils by 4 to 6 times. The other important objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base

courses. Soil stabilization is used to construct the entire road not only in developing countries but also in developed countries. In the past, soil stabilization was done by utilizing the binding properties of clay soils, cement-based products such as soil cement, and/or utilizing the "rammed earth" technique (compaction) and lime. Some of the 'green technologies' are: enzymes, surfactants, biopolymers, synthetic polymers, co-polymer based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fiber reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride and more.

Most of these methods are relatively expensive to be implemented by slowly developing nations and the best way is to use locally available materials with relatively cheap costs affordable by their internal funds.

Udham Singh district is one of the major place of nation. The nearby Pantnagar University is a education hub of state and seen tremendous development in recent past. The C.R.C Bhada village lies at about 1.0 km from P.C.P on a road connecting to Nagla.

2. OBJECTIVE OF THE PRESENT STUDY

The road connecting P.C.P to C.R.C Bhada village serves as lifeline for people residing in village. The road is unmetalled and its condition is deterioting. The condition become very worse during rainy season and there is an immediate needs of its metalling. The proper design of road using waste material will help in saving substancial construction cost.

The various objective of the study can be outlined as:

- Design of unstabilized road based on codal provision.
- Design of stabilized road based on codal provision.

3. MATERIAL USED

3.1 Soil

The soil for this study was procured from the campus of G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India. Fig.1 represents location of study area in G.B. Pant University of Agriculture & Technology, Pantnagar. The material was extracted from 60cm below the ground surface. As per IS: 2720 (Part 4)-1985, the soil was classified as CL which comprises of 61.4% silt and 15.0% clay (Table 1).

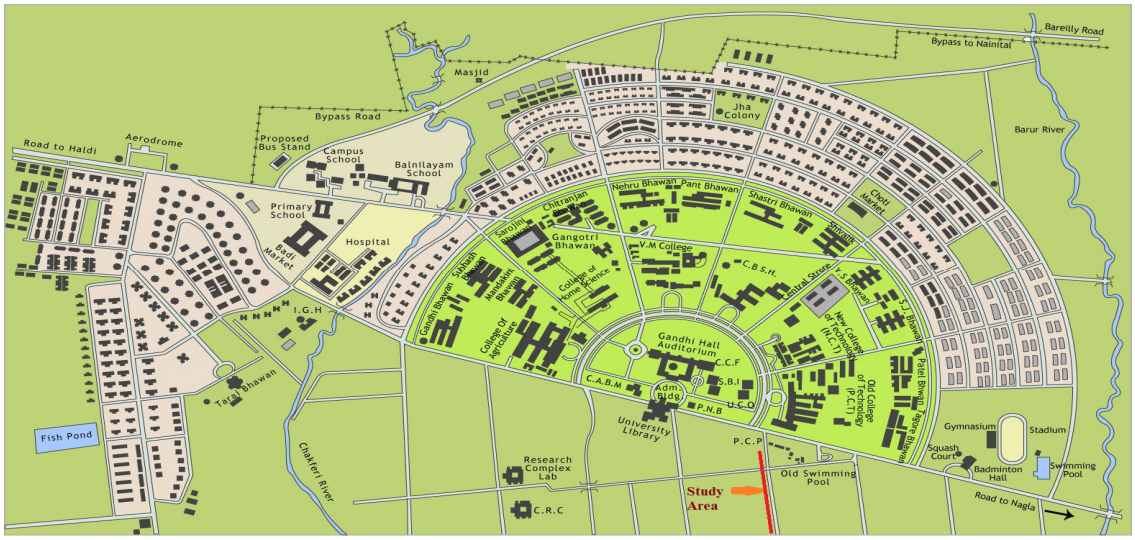

Fig.1 Study Area in Pantnagar

Table 1 Index properties of soil

Property	Value
Natural Moisture Content (%)	11.11
Particle Size distribution Sand (%) Silt (%) Clay (%)	 23.6 61.4 15
Specific Gravity	2.40
OMC (%) MDD (g/cm^3)	16.25 1.76
CBR Soaked (%)	1.95

3.2 Stone Dust

Stone Dust is taken from Pal stone industry situated near Halduchaur, district Nainital (Uttarakhand). Fig.2 shows location of Pal stone industry, Distt., Nainital, (Uttarakhand). The physical and geotechnical parameters to characterize stone dust are the same as those for natural soils, e.g., specific gravity, grain size, consistency limits, compaction characteristics, soaked CBR and shear strength parameters. A change in any of the above factors can result in detectable changes in the properties of the stone dust produced. As per IS: 2720 (Part 4)-1985, the stone dust falls in the category of SP. The procedures for determination of these parameters are also similar to those for soils. Table 2 represents index properties of stone dust.

Fig.2 Location of Pal Stone Industry in dist. Nainital

Table 2 Index properties of stone dust

Property	Value
Natural Moisture Content (%)	9.11
Particle Size distribution Sand (%) Silt (%)	 97.1 2.9
Specific Gravity	2.76
OMC (%) MDD (g/cm^3)	11.5 1.97
CBR Soaked (%)	11.5

4. EXPERIMENTAL PROGRAMME

The soil was mixed with different percentages of stone dust (namely 10, 20, 30, 40 and 50%) by dry weight of soil sample. By conducting a series of compaction and soaked CBR tests, the optimum percentage of soil-stone dust mix was determined.

4.1 Compaction test

The compaction characteristics of the soil, stone dust and soil-stone dust mixes were studied using Standard Proctor Test. The equipment used for this test is SCM 3 Compaction Apparatus manufactured by Associated Instrument Manufacturers (India) Private Limited, New Delhi. The tests were conducted as per IS: 2720 (Part 7)-1980 using a mould of 1000 ml volume.

4.2 CBR test

The apparatus used to conduct this test is HS 20.10 California Bearing Ratio Test Apparatus (Motorized–Single Speed) manufactured by Hydraulic and Engineering Industries, New Delhi. CBR is one of the vital parameter used in the evaluation of soil sub grades for both rigid and flexible pavements design. It is also an integral part of several pavement thickness design methods. Soaked CBR tests were conducted in accordance with IS: 2720 (Part 16)-1987. Tests were conducted on soil, stone dust and soil-stone dust mixes.

4.3 Design of Rural Road

Designing of roads involves geometric design as well as pavement design. The standards for geometric design provide for appropriate parameters as well as the standards for them, keeping in view the functionality of rural roads, with the main objective of providing safe and efficient roads. However, the pavement design controls the economy in road construction with a wide choice of methods of design and materials used in the construction.

5. RESULTS AND DISCUSSION

5.1 Effect of Stone Dust on Compaction and CBR properties of soil

The MDD of soil was found to increase with the increase in percentage of Stone Dust. On the other hand, OMC of soil decreases with the increase in percentage of Stone Dust (Table 3). The CBR of soil first increases with the increase in percentage of stone dust from 0% to 30% and subsequently it decreases on further increasing the stone dust content to 50%. Thus optimum percentage of soil + stone dust mix is at 30% (Table 3).

Table 3 Summary of Experimental Results

S. No.	Material	OMC, %	MDD, g/cm^3	CBR, %
1	Soil + 0% Stone Dust mixes	16.25	1.76	1.95
2	Soil + 10% Stone Dust mixes	15.25	1.83	2.43
3	Soil + 20% Stone Dust mixes	14.25	1.84	2.57
4	Soil + 30% Stone Dust mixes	14.25	1.85	2.91
5	Soil + 40% Stone Dust mixes	13.50	1.87	2.55
6	Soil + 50% Stone Dust mixes	13.25	1.89	1.95

5.2 Designing

Design Crust thickness for single-lane carriageway is based on CBR values (Table 4)

Table 4 Pavement Thickness for Unstabilized and Stabilized Soil

Soil	CBR (%)	Road Length (km)	Cummulative Traffic (msa)	Design thickness (mm)	Proposed thickness (mm)	Granular Sub-Base (mm)	Granular Base (mm)	Binder Course (mm)	Wearing Course (mm)
Unstabilized	1.95	1.0	2	735	735	440	225	50 BM	20 PC
Stabilized	2.91	1.0	2	620	620	325	225	50 BM	20 PC

6. CONCLUSIONS

- Optimum percentage of soil and stone dust mix is found to be 30% based on CBR value.
- There is significant reduction in design of pavement thickness for stone dust stabilized soil.
- The pavement thickness for unstabilized soil is 735 mm while that of stabilized soil is 620 mm (Table 4).
- The reduction of about 115 mm or 18% in pavement thickness will save substantial amount of money in construction.

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